



TES temperature retrievals: Systematic errors from a forward model perspective

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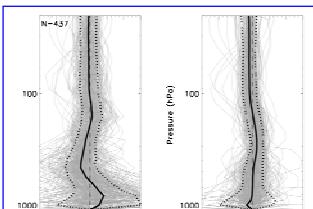
Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA, 91109, USA

Temperature field must be as accurate as possible for passive infrared atmospheric species retrievals

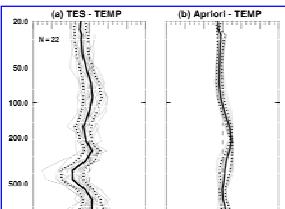
TES Temperature Comparisons

- NCEP sondes (global dataset)
- TES global surveys
- Winter/spring 2006

- WAVES comparisons
- Beltsville, Maryland
- Summer 2006



Comparison of V003 with RS90/92s
TES colder than sonde: 200-600 hPa
TES warmer than sonde: 600-1000 hPa
Biases not apparent in GEOS5/sonde



Comparison of V003 with RS92s
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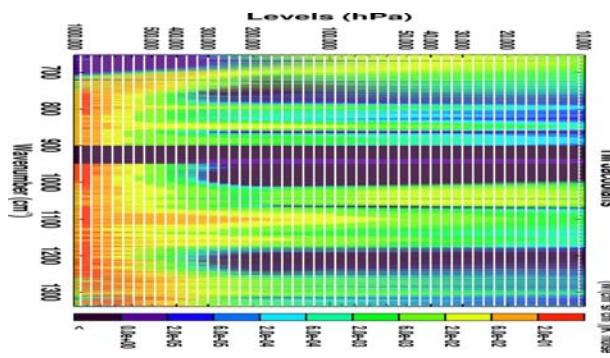
TES Retrievals

- Joint retrieval of TATM, H₂O, O₃, TSUR and cloud
 - Systematic errors in one will propagate into the others (e.g. temperature)
- **CONSISTENCY IS CRUCIAL**
- Potential sources of systematic error:
 - Forward model:
 - » Spectroscopy
 - Line parameters
 - Continuum absorption
 - » Surface emissivity
 - Ocean emissivity is well characterized
 - Land surfaces are more difficult
 - » Cloud parameters
 - Over land: may be difficult to distinguish broad spectral features due to cloud/surface
 - TES Measurements
 - Sonde Measurements
 - Retrieval Approach (e.g. impact of water vapor on temperature)
 - Sampling errors (between satellite and sonde)

TES Retrievals

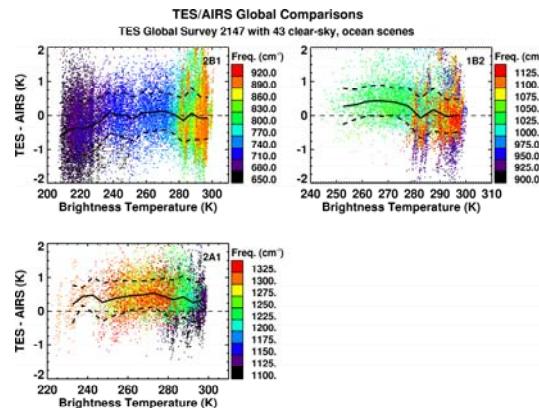
- CO₂ v2 region (600-800 cm⁻¹, TES 2B1 band)
- O₃ region (950-1100 cm⁻¹, TES 1A1 band)
- H₂O region (1200-1600 cm⁻¹, TES 2A1 band)

Temperature Jacobians (scaled by NESR)



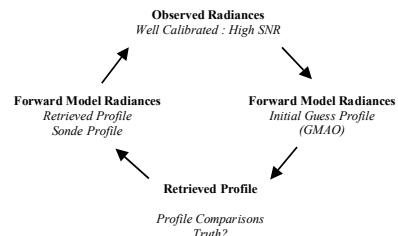
- Consistency within a band
- Consistency between bands
 - AIRS v₂ and v₃ bands to investigate consistency for CO₂
- Consistency between species
 - Temperature Retrievals
 - O₃, H₂O, and CO₂

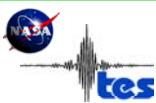
TES/AIRS Radiance Validation



Investigate Systematic Error Sources

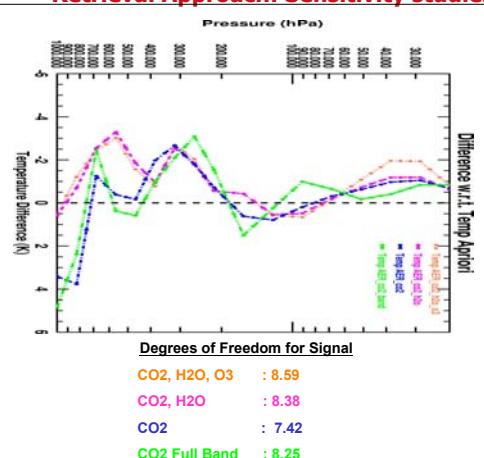
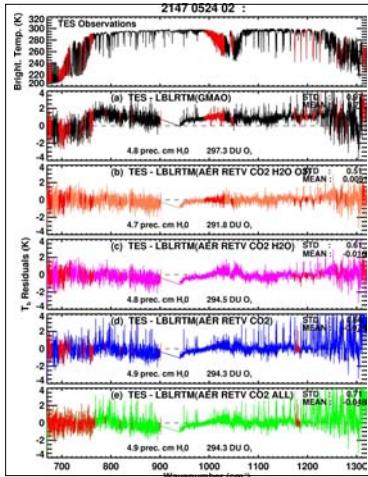
- Spectral Residuals are Key!
- Use the additional information available in the spectrum itself
- Radiance closure studies





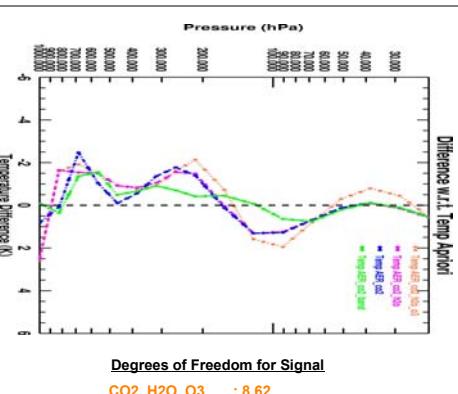
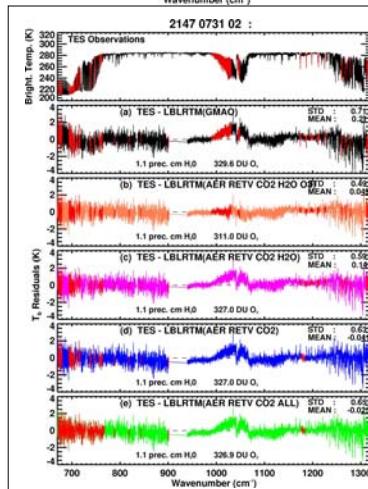
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Retrieval Approach: Sensitivity studies



High water vapor

- Clear sky, over ocean
- A priori temperature: GEOS-5
- Sensitivity study:
a priori is not "truth"!
- Simultaneous retrievals



Temperature retrievals:

- CO₂, H₂O, O₃ (TES microwindows)
- CO₂, H₂O (TES microwindows)

Impact of O₃ region:
minimal

- CO₂ (TES microwindows)

Impact of H₂O region: significant

- CO₂ (full v2 band)

Increased sensitivity at low altitude

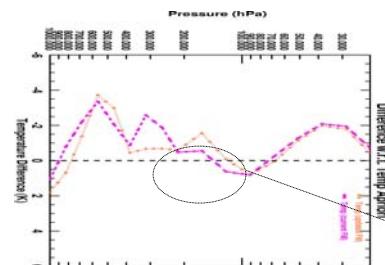
Low water vapor

Impact of Forward Model (LBLRTM) Update

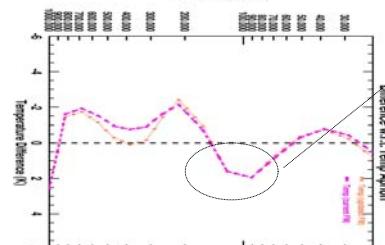
Forward model updates (beta version)

- CO₂
 - Includes line coupling for all the CO₂ bands supplied by Hartmann
 - » New continuum
 - » No adjustment to HITRAN strengths/widths
 - Validation using AIRS
 - » both v2 (600-800 cm⁻¹) and v3 (2200-2400 cm⁻¹) regions
 - » offers improved consistency between CO₂ v2 and CO₂ v3
 - Validation with SHIS data for v2 region in progress
- H₂O
 - HITRAN have released updated H₂O line widths
 - » Effect is of order of tenths of K in T_b in TES MWs (up to 0.5 K)
- O₃
 - HITRAN 2004 parameters are different than tes_v_1.3 (MIPAS)
 - Differences of order of 0.1K in T_b in TES O₃ region
- PRELIMINARY SENSITIVITY STUDY: EFFECT ON RETRIEVALS

High water vapor



Significant impact in middle to upper troposphere



Low water vapor

Comments

- Water vapor spectral region impacts simultaneous temperature retrievals
 - Inconsistency between CO₂ and H₂O spectral regions
 - Forward model (e.g. spectroscopy)?
 - Instrument calibration?
 - Impact of retrieval approach?
 - Preliminary results from forward model update sensitivity indicate potential improvement to upper tropospheric temperature bias